Energy & Environmental Research Center

Center for Biomass Utilization

EERC

University of North Dakota
Grand Forks, North Dakota

EERC Center for Biomass Utilization

Biomass is a strategic resource in the United States as evidenced by numerous "greening" initiatives launched by federal and state governments and, more importantly, by the increase in biomass-derived products. The Energy & Environmental Research Center (EERC) Center for Biomass Utilization (CBU), located on the campus of the University North Dakota (UND), conducts critical research in biomass utilization. The CBU grew out of industry-funded research and development to utilize an array of biomass resources for fuel and energy. Currently, nearly $5 million of activities are funded in the CBU through industry investment; local, state, and federal government contracts; and industry–government joint ventures.

Harvesting fast-growing hybrid poplar trees for energy production in Minnesota.

Mission

The mission of the CBU is to develop technologies for, and promote the use of, biomass for production of biopower, transportation biofuels, and bioproducts as well as mitigate the technical challenges associated with biomass utilization.

Objectives

Specific objectives of the CBU include:

- Developing methods for cofiring biomass with coal and other fossil fuels.
- Developing biomass fuels for utility- and industrial-scale power systems.
- Establishing small-scale distributed energy systems.
- Developing advanced power systems that utilize biomass (gasifiers, fuel cells, ultrasupercritical boilers).
- Researching and demonstrating new bioproducts from agricultural residues, energy crops, and forest residues, such as ethanol, ethanol-derived oxygenates, biodiesel, lactic acid, foods, fiber, and chemicals.
- Promoting education on biomass potential.

Coarsely chopped switchgrass being prepared for cofiring with coal.

What Is Biomass?

Biomass is any organic material that is available on a renewable basis for energy or products. Types of biomass include agricultural residues or coproducts like corn stover, alfalfa, wheat straw, and rice straw; dedicated fast-growing energy crops like switchgrass and hybrid poplar and willow trees; forest and manufacturer wood residues; municipal solid wastes; and animal wastes or manures.

Impacts of Biomass Utilization

Successful implementation of biomass utilization will result in:

- Decreased accumulation of greenhouse gas, which has been implicated in global warming.
- Reduced waste volumes of biomass.
- Improved air, water, and soil environmental quality by promoting cleaner bioenergy, environmentally friendly fuels, and biodegradable materials and products.
- Increased national security by utilizing domestic renewable energy and fuel resources.
- An enhanced U.S. economy by establishing new agricultural markets, transportation fuel businesses, and refinery and manufacturing industries that use biomass resources.
- Diffusing international tensions by promoting biomass resources and technologies in developing nations.

Blended sunflower hulls and western U.S. coal prepared for cofiring in UND's steam plant.

Testing the feasibility of cofiring wood residue biomass with lignite at the North Dakota State Penitentiary.

Projects in Biopower

Several ongoing biopower projects are directed toward large electrical utility boilers and small district energy systems:

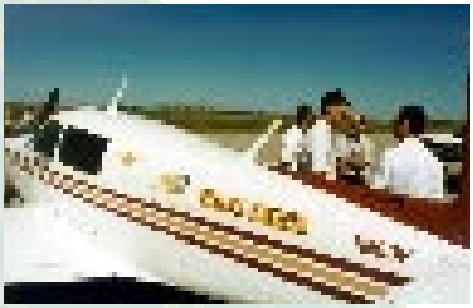
Bales of Iowa switchgrass that can be used for biopower and bioproducts.

- The potential of lignin residues derived from ethanol production from processing of rice straw, wood, and municipal solid waste for power production and as chemical feedstocks.
- Barriers to fuel processing, ash deposition, emissions, and boiler tube corrosion associated with cofiring biomass.
- The first project in the United States to demonstrate cofiring wood biomass with lignite coal at the North Dakota State Penitentiary.
- Cofiring sunflower hulls with coal at the University of North Dakota steam plant.
- Cofiring performance of switchgrass, alfalfa, wheat straw, waste wood, sunflower hulls, and hybrid poplar with coal.
- Small biopower district energy systems and gasification technologies.
- Biomass-derived fly ash as an additive in concrete and construction materials.
- A biomass feed system for the world's largest gasifier.
- Converting potato wastes to methane for power.
- Biomass pyrolysis char by-products for heat, power, or syngas.
- Chicken and turkey manure as a reburn or cofiring fuel with coal for lowering NO_x emissions.
- Liquefaction of biomass to produce power fuels.

Rice straw lignin derived from ethanol production as a by-product and prepared as a power fuel.

Projects in Transportation Biofuels

- Ethanol and methanol as feedstocks for producing high-octane gasoline additives with superior blending properties.
- Clean, efficient alternative transportation fuels through the Red River Valley Clean Cities Program.
- Potential environmental impacts of ethanol use in gasoline.
- Ethanol-based aviation fuel for piston-engine aircraft.
- The performance and emission benefits of ethanol- and biodiesel-blended diesel fuels.
- Ethanol from lignocellulosic biomass.



Ethanol and biodiesel are being blended with aviation fuels to produce certified, cleaner-burning fuels.

Projects in Bioproducts and Biochemicals

- Converting ag processing plants into biorefineries that produce a suite of fuels and chemicals.
- Adhesives from wood biomass.
- Bioplastic and biosolvent precursors based on ethanol and biomass-derived organic acids.
- Lactic acid and other high-value chemicals from ag processing wastewaters.
- Innovative concrete cement additives derived from biomass.
- Ethanol and biomass fermentation products as feedstocks for producing monomers for biodegradable polymers, industrial solvents, and other industrial chemicals.

Many petrochemical-based products can be replaced or enhanced with biomass products.

Biomass-derived fly ash from energy production has uses in concrete.

Research and Services Offered by EERC CBU

The CBU provides expertise in several areas of biomass utilization for industry, stakeholders, state agencies and institutes, and entrepreneurs:

- Biomass feedstock assessments
  - Identification of feedstocks and suppliers
  - Quantification of feedstock and determination of long-term supply reliability
  - Costs: realistic fuel worth and costs, transportation, and tipping fees
  - Benefits assessment: tax credits, emission credits, green power incentives, and fuel cost savings
- Biomass combustion and gasification testing and demonstration
  - Customized pilot- and bench-scale testing
  - Units designed to test small quantities of biomass
  - Expertise and equipment for full-scale boiler evaluations
  - Ash deposition (fouling and slagging) assessments
  - Air toxic emission evaluations
  - Biomass fuel handling and processing: chipping, shredding, pulverizing, drying, densification, and other physical property assessments
- Ethanol and biodiesel plant siting
  - Agricultural feedstock supply
  - Energy requirements
  - Pipelines and shipping
  - Construction and infrastructure
  - State and federal incentives
- Fuel formulations for ethanol and biodiesel with petroleum fuels
  - Complete organic chemistry laboratory for testing fuel properties
  - Combustion laboratory for performance and emission tests
  - Aviation-grade blends of biodiesel, ethanol, and petroleum diesel
  - E85 blends and B20 blends for automotive transportation
  - Assessments and tests of small fuel quantity combustors and gasifiers
  - Full inorganic and organic laboratory analysis capabilities

Lab-scale combustion testing of varieties of biomass energy fuels.

- Biorefinery evaluations
  - Production of chemical products from cellulosic and commodity-type biomass feedstocks
  - Plastics, solvents, lubricants, additives, biodegradable materials, perfumes, nutritional supplements, and pharmaceuticals

Scanning electron microscopy to determine the interaction of alfalfa and coal combustion ash.

For More Information

Thomas A. Erickson
Associate Director for Research
Telephone: (701) 777-5123
E-mail: terickson@undeerc.org

Christopher J. Zygarlicke
Senior Research Manager
Center for Biomass Utilization
Telephone: (701) 777-5123
E-mail: czygarlicke@undeerc.org

Energy & Environmental Research Center
PO Box 9018 Grand Forks, ND 58202-9018
Phone: (701) 777-5000
Fax: (701) 777-5181
www.undeerc.org

"It would be extremely short-sighted not to . . . move toward ameliorating all of the risks [associated with Middle Eastern oil] by beginning to substitute carbohydrates for hydrocarbons."

— Former U.S. CIA Director R. James Woolsey